appears as but efflux of one and the same all-comprehensive law of nature. The great law of the conservation of force thereby finds its universal application, embracing also those biological provinces which hitherto appeared closed to it.

In face of the surprising velocity with which in these last years the development theory has paved an entrance into the most diverse departments of inquiry we may here express the hope that its high pedagogic value also will be even more recognised, and that it will quite perfect the education of the coming generations. When five years ago, at the fiftieth Meeting of Naturalists in Munich, I laid stress on the high significance of the development theory in relation to education, my remarks were so misunderstood that a few words of explanation may here be allowed me. It stands to reason that with these words I could not mean to claim that Darwinism should be taught in elementary schools. That is simply impossible. For just like the higher mathematics and physics, or the history of philosophy, Darwinism demands a mass of previous knowledge which can be acquired only in the higher stages of learning. Assuredly, however, we may demand that all subjects of education be treated according to the *genetic method*, and that the fundamental idea of the development-theory, the *Causality of Phenomena*, find everywhere its acknowledgment. We are firmly persuaded that by this means, thinking and judging conformably with nature will be promoted in far greater measure than by any other method.

At the same time through this extended application of the development-doctrine, one of the greatest evils of our day in the culture of youth will be removed—the cramming of the memory, we mean, with dead lumber, which smothers the best powers and prevents both soul and body from coming to a normal development. This excessive cramming is based on the old fundamental ineradicable error that the *quantity* of *factual knowledge* is the best measure of culture, while, in truth, culture depends on the *quality* of causative *science*. We would therefore deem it especially useful that the selection of the material of instruction be much more carefully made, and that in making the selection, those departments which cram the memory with masses of dead facts do not receive the preference, but those which cultivate the judgment through the living stream of the development idea. Let our worried school youth only learn half as much, but let them understand this half more thoroughly, and the next generation will in soul and body be doubly as sound as the present.

In the most gladdening manner these requirements are being met by the reforms which are simultaneously in process of accomplishment in the most diverse provinces of science. Everywhere is stirring and moving fresh young life, stimulated by the idea of natural development—in the Comparative Study of Languages and in the History of Culture, as also in Psychology and Philosophy; in Ethnography and Anthropology no less than in botany and zoology. Everywhere the most joyful blossoms are bursting forth from the most varied branches of science, and its fruits will concurrently testify that they all spring from one single tree of knowledge and draw their nourishment from one single root. Thanks and honour, however, to the great masters who by their genetic and monistic theory of nature have led us to this clear height of knowledge from which with Goethe we may say:

> "Dieser schöne Begriff von Macht und Schranken, von Willkür
> Und Gesetz, von Freiheit und Mass, von beweglicher Ordnung
> Vorzug und Mangel, erfreue dich hoch; die heilige Muse
> Bringt harmonisch ihn dir, mit sanftem Zwange belehrend.
> Keinen höhern Begriff erringt der sittliche Denker,
> Keinen der thätige Mann, der dichtende Künstler; der Herrscher,
> Der verdient es zu sein, erfreut nur durch ihn sich der Krone.
> Freue dich höchstes Geschöpf der Natur, du fühlest dich fähig,
> Ihr den höchsten Gedanken, zu dem sie schaffend sich aufschwang
> Nachzudenken. Hier stehe nun still und wende die Blicke
> Ruckwärts, prüfe, vergleiche und nimm vom Munde der Muse,
> Dass du schauest, nicht schwärmst, die liebliche volle Gewissheit."[1]

OUR ASTRONOMICAL COLUMN

THE BINARY STAR 70 OPHIUCHI.—This star has received even more than a fair share of attention at the hands both of observers and computers, but there remain notwithstanding large outstanding differences between observation and calculation. As regards the orbit a very complete discussion of all the reliable measures to 1868, was made by Dr. Schur of Strasburg, while with eight years later measures, the elements were rigorously investigated by M. Tisserand in a memoir published by the Academy of Sciences of Toulouse. If Dr. Doberck in the course of his skilful and elaborate researches on the motion of the binaries has given attention to this star, his results have escaped our notice, but we subjoin the orbits deduced by Dr. Schur and M. Tisserand:—

	SCHUR.	TISSERAND.
Periastron passage ...	1808·791	1809·664
Node	125° 22′	127° 22′
Node to periastron ...	155° 44′	149° 44′
Inclination	57° 56′	60° 0′
Excentricity	0·49149	0·47287
Semi-axis major	4″·704	4″·770
Period of revolution ...	94·370 years	94·929 years.

In 1879 the star was measured by Prof. Asaph Hall on five nights with the 26-inch refractor at Washington, generally under a magnifying power of 600; his epoch is—

1879·588 ... Position, 71°·32 ... Distance, 2″·930

Comparing with Schur's elements we find—

$$dP\,(c-o) = +\,5^\circ\!\cdot\!61 \quad \ldots \quad \ldots \quad dD = +\,0''\!\cdot\!726$$

While the errors of Tisserand's orbit are—

$$dP = +\,3^\circ\!\cdot\!01 \quad \ldots \quad \ldots \quad \ldots \quad dD = +\,0''\!\cdot\!497$$

The question naturally arises, how is it that after the most careful and complete determination of the orbit, it happens that in so short a time after the date of the latest measures employed in the calculations, the star appears to *bolt*, so to say, from its predicted course.

There have been suspicions from time to time that perturbation is indicated by the apparently anomalous differences between observation and computation. Mädler, discussing the elements of the orbit in 1842, when truly he had but a very limited and comparatively imperfect series of measures at his command to what we can now utilise, went so far as to doubt the efficiency of the theory of gravitation to explain the motion of the components of this double star, or at least he considered the question reduced to one of two alternatives, which he thus presents:—

(1) "The motion in this binary system does not follow the Newtonian law."

Or (2) "The middle point of the images which the stars form to us is not the centre of gravity of the masses."

And he recommended the star to close scrutiny with the most powerful instruments, with the view to ascertain whether there were any visible disturbing body.

The existence of a third star was suggested by Jacob, to explain similar anomalies which he believed to have been indicated by the measures, but Mr. Burnham, in 1878, examined 70 Ophiuchi with the 18½-inch Alvan Clarke refractor at Chicago with only negative evidence: "Both stars were perfectly round, with the highest powers on this occasion, . . . and no trace of any third star near." Such had also been his previous experience.

It thus becomes all the the more desirable to ascertain how far the suspected deviations from unperturbed motion may exist in the observations themselves, and more attention might perhaps be given with advantage to the investigation of personal equation between the various observers, the elimination of the effect of obliquity of direction of the components, or other cause which could possibly affect the comparison of the separate results. The evidence that such influences exist is pretty evident in the case of this particular star. For instance if we compare the above orbits with an epoch, only one year later than that of Prof. Hall, viz., Jedrzejewicz's for 1880·656, giving the position 62°·82, distance 2″·75, we get the following differences between calculation and observation:—

In Schur's orbit ... ... $dP = +10^\circ\!\cdot\!81$ ... $dD = +0''\!\cdot\!72$
In Tisserand's orbit ... $dP = +\ 7^\circ\!\cdot\!88$ ... $dD = +0''\!\cdot\!51$

Exhibiting an increase of errors in the course of a year which cannot be wholly attributed to errors of elements depending upon a long course of measures.

Another circumstance connected with 70 Ophiuchi, which is attended with some difficulty of explanation, may be mentioned here. Prof. Hall, in addition to measuring the principal com-

[1] This fair idea of might and limit, of will and law, of freedom and measure, of order in movement, of excellence and defect, gladden thee deeply; the holy Muse brings it harmoniously to thee, instructing thee with generous constraint. No higher idea achieves the moral thinker, no higher the active man, the creative artist; the regent worthy to rule finds happiness in his crown through this idea alone. Rejoice, oh highest creature of Nature, that thou feelest thyself able to think after Nature the highest thought to which the creatively soared. Here now stand still, and turn thy looks backwards, examine, compare, and hear the words of the Muse, that without illusion thou mayest contemplate the full, lovely truth

panion in 1878, also measured two small neighbouring stars which he estimated of "about the 13th mag." with these results—

(*a*) 1878·842	...	Position $49°·59$	...	Distance $87''·209$
(*b*) 1878·842	...	,, 197·85	...	,, 71·384

Secchi, in *Memorie dell' Osservatorio del Collegio Romano*, 1859, p. 119, publishes measures of "70 *p* Ofiuco preso colla più vicina," thus:—

1856·627	...	$215°·08$	...	$87''·574$ (4)	... 11m.
1856·627	...	67·2	...	... ... (4)	... 12m.

The proper motion of 70 Ophiuchi by comparison of Bradley with the Greenwich catalogue of 1872, appears to be $+0''·2014$ in right ascension, and $-1''·1170$ in declination, and transferring with the aid of these values Hall's angles and distances to Secchi's epoch, we find:—

(*a*)	... 1856·627	...	$190°·63$	...	$94''·38$
(*b*)	... 1856·627	...	65·89	...	77·65

It can hardly be doubted that Secchi's stars are identical with Hall's, but the difference in both position and distance of the star (*a*) seems to merit further examination; if there be no error in Secchi's measures proper motion of the thirteenth magnitude, as Hall estimated it, is probable.

Smyth refers somewhat vaguely to two small companions of 70 Ophiuchi; at his first date the Washington measures carried back as above would give:—

(*a*)	... 1830·76	...	$87°·9$	...	$76''·1$
(*b*)	... 1830·76	...	185·7	...	122·3

THE GREAT COMET OF 1874.—Mr. T. W. Backhouse writes from Sunderland, pointing out that the tail of this comet attained a much greater length than was assigned in this column, p. 483. The length there mentioned 23°, was that given by observation in the suburbs of London on July 13, when the head of the comet was about to descend below the horizon. On the same evening Mr. Backhouse found the tail 26° long, and 35° on the 14th, and he refers to greater lengths subsequently noted. These, however, refer to dates when the head was no longer visible in these latitudes, Prof. Julius Schmidt gave the following estimations made at Athens:—

July 16 ... $47°·2$	July 18 ... $55°·9$	July 21 ... $65°·8$
17 ... 54·0	20 ... 63·3	22 ... 64·6

These, with other observations, will be found in his description of the appearance of the comet, in No. 2067 of the *Astronomische Nachrichten.*

BIOLOGICAL NOTES

COLOSSAL CUTTLE-FISH.—Mr. T. W. Kirk adds to our rapidly-increasing knowledge of large cuttle-fish in an important paper lately published (*Trans.* New Zealand Institut. vol. xiv). One species referred by him to Steenstrup's genus Architeuthis, and called *A. verrilli*, was found stranded at Island Bay, Cook's Strait, New Zealand, in June, 1880. When first found on the beach, it was not quite dead; the longer arms measured twenty-five feet; the blades had a row of fifteen suckers along each side and a middle row of nineteen. The smaller arms were about eleven feet nine inches, with a width of seven and a half inches. They were furnished with suckers and fleshy tubercles, but these shorter arms were of unequal length. The fleshy membrane connecting these was about eleven inches deep. The head was four feet three inches in circumference, the eyes five inches by four; the body was seven feet six inches in length, and nine feet two inches in its greatest circumference. While this large cuttle differs in some respects from the type of Steenstrup's genus, Mr. Kirk prefers to wait for fresh material ere creating a new genus. Another large cuttle is referred to a new genus, Steenstrupia, but its long pair of arms had been torn off at a length of six feet two inches, when it was found in Cook's Straits; its body was long (nine feet two inches), almost cylindrical, but very slightly swollen in the middle, head long (one foot eleven inches), narrow sides, nearly straight, eyes larger, and with lids, sessile arms, all same length and size (four feet three inches), suckers, thirty-six on each arm, in two equal rows, each with a bony ring armed with from forty to sixty sharp incurved teeth. The fin was rhomboidal, posterior lateral. The internal shell was six feet three inches long. The new species is called *S. stockii.*

JAPANESE COTTON.—The Japanese Government have lately presented to the National Museum of the United States an interesting collection of cotton grown in Japan, accompanying the donation with notes on the specimens, from which we extract the following:—Cotton is produced along the coasts of the districts Kinai, Kanto, Chiugoku, and Kiushiu, where the soil is sandy and the climate warm. In some of the north-eastern parts, where there are early frosts, the attempt to cultivate cotton is rarely made. It is uncertain when the cultivation of cotton in the Japanese empire first commenced, but it would appear that the method of culture adopted in the western provinces came from Kinai, though the seeds grown in the eastern provinces came from Mikawa. In the province of Settsu the crop is the largest, indeed is not surpassed by that of all the other provinces, but the cost of cultivation is high. The staple, moreover, is rather short and hard, so as not to be suitable for very fine yarns. In recent years, however, cotton yarns are imported on a large scale, and fine yarns are easily procured; so the home-produced cotton is profitable in proportion to its yield. This will account for the fact that the cultivation of the long and soft staple is quickly passing away, and that it is becoming the almost universal custom to grow only that seed which will produce a maximum yield. While cotton plants have different names in the different provinces, it is believed that there are but three sorts—the Kanto, which produces a long, soft, and strong staple of glossy appearance, from half to two-thirds of an inch in length, the Kinai, with a hard and short staple, from a quarter to half an inch in length, and rather destitute of glossiness, and the Ainoko, which is a hybrid between the two former. The cultivation of the cotton-plant in Japan is not uniform, varying immensely according to not only the climates and soils, but also according to the customs of each district, but it is to be expected that with the advance of time the mode of culture may become more uniform, and that excellence in quality may even take the place of a maximum in quantity.

AMERICAN WOODCOCK CARRYING ITS YOUNG.—Whilst it is still somewhat uncertain whether the woodcock (*Scolopax rusticula*, Linn.) of Europe carries its young in its claws or between its legs, we believe this habit has, though referred to by Audubon, not been recently observed in the American woodcock (*Phitohelia minor*). It is, therefore, interesting to note the following observations of Mr. F. L. Harvey, of Arkansas. In April last (1882) a woodcock was flushed from a clump of persimmion trees on the border of a slash. Knowing the bird's habit of rising above a clump of bushes and then suddenly dropping behind it out of range, Mr. Harvey fired as soon as it rose. When the smoke cleared away the bird was seen rising with a laboured flight, and concluding it was wounded its fall was expected, but instead it turned and came nearer. It was seen to be holding something between its feet, which on closer observation proved to be a young chicken recently hatched, which was located between the mother's legs, and supported by her feet placed on its sides. So slow was the flight that by a brisk trot the observer was able to gain on the bird, which he tried to tire out so as to compel it to drop its burden, but in this he was not successful. It would appear that this bird and Wilson's snipe often remain in Arkansas to breed (*American Naturalist*, September).

BLIND SUBTERRANEAN CRUSTACEA IN NEW ZEALAND.—The existence of blind Edriophthalmatous Crustacea in wells and subterranean cave rivers in Europe has been long known, and now Mr. C. Chilton describes some quite new forms found in New Zealand (*Trans.* New Zealand Institute, vol. xiv.). They were obtained from a well at Eyreton, about six miles from Kaiapoi, North Canterbury; the well had been excavated about seventeen years previously, was not more than twenty-five feet deep, and was fitted with a common suction-pump through the medium of which these new forms were obtained. These proved to be three species of Amphipoda and one of Isopoda. In none were there to be found in either the living or recent specimens the least trace of eyes. The Isopod is referred to a new genus Cruregens, and is most remarkable from the fact that it has only six pairs of appendages to the seven thoracic segments, whilst the normal number should be seven. In many Isopods the young have at first only six pairs of legs, the last thoracic segment being but slightly developed and destitute of appendages (Fritz Müller, "Facts and Arguments for Darwin"), and